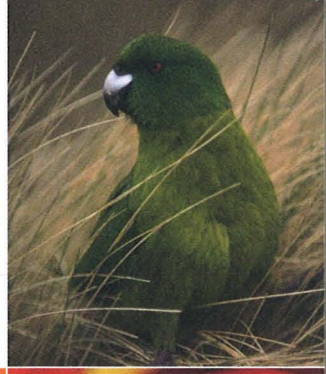
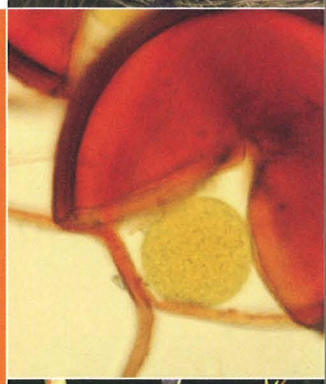
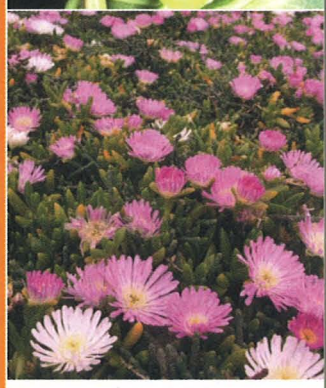


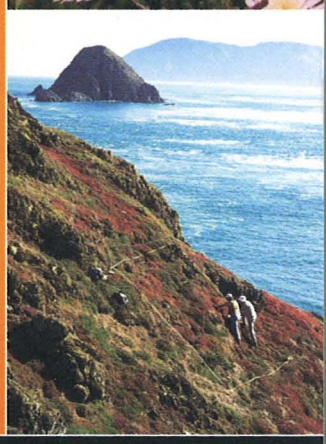
Bio-Protection & Ecology Division



Measuring diversity and abundance of beetles and spiders in ten Port Hills reserves, Canterbury

Mike Bowie





Wildlife Management Report No. 42

CHRISTCHURCH
NEW ZEALAND
www.lincoln.ac.nz

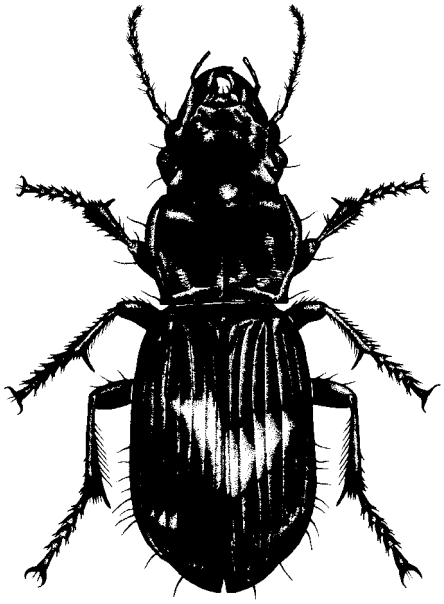
Lincoln University
Te Whare Wānaka o Aoraki

ISSN: 1177-6242
ISBN: 978-0-86476-195-8

Lincoln University Wildlife Management Report No. 42

Measuring diversity and abundance of beetles and spiders in ten Port Hills reserves, Canterbury

Mike Bowie
Bio-Protection and Ecology Division
P.O. Box 84
Lincoln University
Bowie@lincoln.ac.nz



Prepared for:

Port Hills Rangers, Christchurch City Council

June 2007

Introduction

The Regional Parks' Port Hills Rangers (Greenspace Unit, Christchurch City Council) in conjunction with Environment Canterbury are ecologically restoring several reserves on the Port Hills of Canterbury. Flora and fauna (birds and invertebrates) are being monitored to collect information on presence and abundance of native taxa within the reserves. This study, combined with the previous surveys (Bowie and Sirvid, 2004; Bowie and Sirvid, 2005; Bowie and Vink, 2006), will provide baseline invertebrate data for comparisons in future years. It may also enable some effects of ecological restoration through pest management to be measured.

Motels (see Methods) were used to non-destructively sample cavity-dwelling species to provide a snapshot of forest diversity and health (Bowie *et al*. 2003; Bowie and Sirvid, 2004; Bowie and Sirvid, 2005; Bowie *et al*. 2006; Hodge *et al*. 2007). Another non-destructive sampling method uses wooden discs as facsimiles for natural fallen logs to sample large soil-dwelling insects (Bowie and Frampton 2004; Bowie and Sirvid, 2004; Bowie and Sirvid, 2005; Bowie and Vink, 2006). Pitfall trapping is a common method used by entomologists to sample invertebrates (Willet *et al*. 2001). It is an indiscriminate and destructive technique, but does usually collect a broad range of invertebrate taxa and is easily replicated or compared with other pitfall trap studies. Data from pitfall traps, rather than absolute density estimates are often used to measure populations of ground-dwelling invertebrates (Lang, 2000). The likely reason for this is that large numbers of individuals and species can be collected with little labour and expense (Topping and Sunderland, 1992). This work reports on the invertebrate abundance and diversity of 10 reserves on the Port Hills using these two non-destructive sampling methods. Three sites, Sugarloaf 1 and both Kennedys Bush sites (1 & 2) were selected for monitoring over the Oct – Nov 2006 period using the additional pitfall trap method. Only three sites were chosen due to the extra work needed to carry out the pitfall trapping and identifications. The Pitfall trap catches also provides more specimens to allow a Port Hills invertebrate checklist. The main objective of this report is to outline main findings of 2006 invertebrate monitoring at ten Port Hills reserves. A secondary objective is to make recommendations based on 2006 monitoring results and those found in the Kennedys Bush vertebrate pest control review (Thomas, 2007).

Methods

Sites

Motels were used at ten sites in the Port Hills Ecological District (Wilson, 1992) in Canterbury, New Zealand (43°37' S, 172°36' E). At each site a range of tree species were chosen to attach 20 motels. Table 1 gives the location, characteristics and sampling dates for each site.

Motels

Blocks of untreated pine wood 45 x 45 mm in cross-section and 150 mm long, were cut with a 60° 'roof' (see photo). A drill was used to cut a cavity (~30mm wide x 22mm deep x 70 mm long) and a 14mm diameter entrance hole. A glass microscope slide was used as a window and a wooden door slides open for viewing (see photo). A plastic 'roof' cut from white plastic was stapled to the top to reduce rain damage to the wood. Plastic-coated twist-tie wire was used to attach the motels to trees. Twenty motels were attached to trees predominantly around the perimeter of each 20 x 20 m vegetation plot.

Wooden discs

Based on the specifications of Bowie and Frampton (2003), untreated pine discs (350-450 mm in diameter and 100-150 mm thick) were cut from a fallen tree by the Port Hills Ranger Service (CCC) and eight were placed on bare soil around the perimeter of 20 x 20 m vegetation plots at each site (see photo).

Pitfall traps

Five 350 ml honey pots (6628NA, Stowers, Christchurch) were used as pitfall traps at each site and were placed about five metres away from corner discs of each plot, plus one in the middle of

the plot. Each trap was seated in a galvanised sleeve to maintain a good trap/soil interface surface and a galvanised iron roof was used to reduce rain and vegetative debris entering the traps and minimise the removal of trapped invertebrates by birds (see photo). A 95% solution of antifreeze was used as a preservative and 2% detergent (final concentration) was used in the pitfalls as a surfactant. Contents were collected after approximately one month (see Table 1) and kept in a fridge until sorted into 70% ethanol for further analysis.

Sampling sites
Only three sites were sampled as the more labour-intensive pitfall traps were used as an additional method. See site details in Table 1 below:

Table 1: Port Hills sites with locations, sampling details and site characteristics

Sites	**Location**	**Motel attachment dates**	**Disc and motel sample dates**	**Pitfall trap sampling duration**	**Slope and Altitude**	**Aspect and Forest type**
Ahuriri Scenic Reserve	E2479700 N5726750	31 October 2003	13 October 2006		15° 450 m	South facing Podocarp/hardwood
Cass Peak	E2479544 N5729907	13 November 2003	1 November 2006		20° 455 m	South East facing Podocarp/hardwood
Coopers Knob Reserve	E2479590 N5727256	10 November 2003	13 October 2006		35° 480 m	South facing 2nd growth mixed hardwood
Kennedys Bush 1	E2479160 N5730935	26 November 2003	17 October 2006	19 October – 23 November 2006	30° 280 m	South East facing Podocarp/hardwood
Kennedys Bush 2	E2479647 N5730596	7 November 2003	17 October 2006	17 October – 16 November 2006	25° 390 m	South West facing Second growth kanuka
Orongomai Reserve	E2479674 N5730004	13 November 2003	26 October 2006		25° 460 m	South East facing Podocarp/hardwood
Otahuna 1	E2478885 N5728169	26 November 2003	1 November 2006		15° 240 m	South East facing Second growth mixed hardwood
Otahuna 2	E2478410 N5728883	26 November 2003	1 November 2006		15° 185 m	South facing Podocarp/hardwood
Sugarloaf 1	E2481800 N5733515	7 November 2003	26 October 2006	26 October – 23 November 2006	30° 320 m	South East facing Second growth mixed hardwood
Sugarloaf 2	E2481810 N5733565	7 November 2003	17 October 2006		30° 370 m	East facing Second growth mixed hardwood

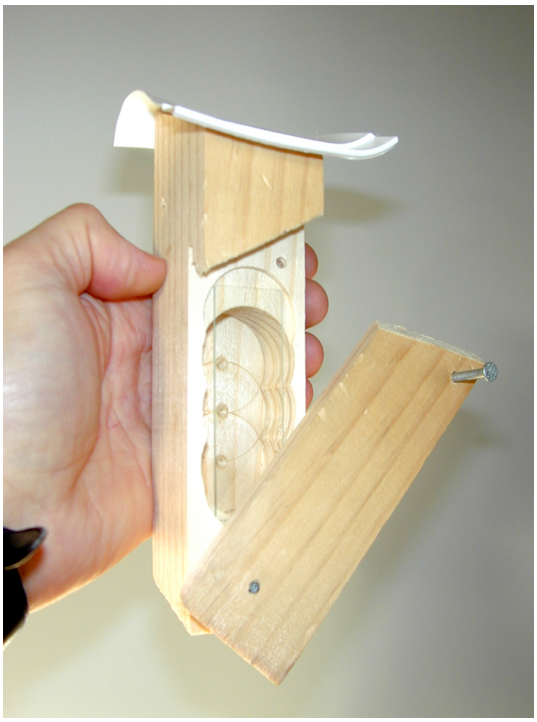
Invertebrate identifications
Occupants were identified in motels or under discs to the best of my ability.

Analysis
Beetles from the pitfall traps were identified and used for diversity analysis as there are more than 5000 native New Zealand beetle species and the most diverse group of animals on earth (Klimaszewski and Watt, 1997). The ecological roles of beetles include carnivores, herbivores, fungivores, and scavengers, which make them good indicators of ecological restoration.

Species diversity was calculated using only ground beetles (Coleoptera: Carabidae) found under the wooden discs. Invertebrate diversity was calculated by combining carabids under discs and spiders (Araneae) found in motels. Pitfall beetles were also used to compare the relative diversities of the three reserves. The Shannon-Wiener index of diversity (Krebs, 1989) calculated

for each reserve using log base 10 (rather than natural log). This index incorporates species richness and numbers of each species to give a measure of heterogeneity or evenness of species in populations at each site. Carabid diversity was calculated from both pitfall trap and wooden disc data and compared.

Pitfall Trap design used in this study



Motel used to monitor arboreal invertebrates

Wooden discs used to sample ground-dwelling invertebrates e.g. carabids

Results

Occupancy
Live occupancy in the motels was lowest at Sugarloaf 1 with 75%, while Ahuriri and Cass Peak and Kennedys Bush 1 were all 95% full. Overall, *Neoramia* species were the most common spider found in motels and contributed to 58% of all spiders, while Theridae (*Theridion zantholabio* and *Achaearanea veruculata*) made up the second most common species with 19% collectively (Appendix 1).

Diversity
In terms of carabid species diversity, there was a mixture of results (Figure 1). Five sites have increased in diversity on 2003 values, two sites were identical and three sites decreased in species diversity.

Pitfall traps collected 65 beetles at Sugarloaf 1. (Figure 2; Appendix 3). This was considerably more than at Kennedys Bush, with 42 and 31 for sites 1 and 2 respectively. The main contribution to this was 15 specimens of *Holcaspis suteri* (Appendix 3). Sugarloaf 1 was also had the most diverse taxa of the three sites with 23 beetle species caught in pitfalls.

Seven carabid species were found from the three pitfall sites on the Port Hills, which was identical to last year's results when Ahuriri, Coopers Knob and Orongomai were sampled using pifall traps.

Abundance
The sum number of spiders collected from motels and carabids collected from discs for each site showed Ahuriri to be the most abundant followed by the two Kennedys Bush sites in 2006 (Figure 4). Orongomai had the lowest abundance. When compared to data from 2003, only Cass Peak had higher numbers of spiders and carabids in 2006.

Checklist of significant carabid species
The finds of the 'rarer' carabids were *Dicrochile whitei* and *Onawea pantomelas* (Appendix 2 and 3).

Other beetle species
Many stag beetles (*Paralissotes reticulatus*) were found in discs where they were in damper situations and discs had softened due to decay. Kennedys Bush 1, Otahuna 2 and Sugarloaf 2 had between five and 13 adults or larvae under the discs, and many more larvae were likely to be inside. One interesting find was a single specimen in the family Scraptiidae.

Comparison of collecting methods
Only pitfall traps at Sugarloaf 1 (of the 3 sites) collected larger numbers of carabids over the four week period than found under the wooden discs (Table 2). At this site four times as many carabids were in the pitfalls that under discs, whereas twice as many carabids were found under discs than in pitfalls at the two Kennedys Bush sites.

Figure 1: Carabid species diversity under discs at ten Port Hills reserves in 2003 and 2006

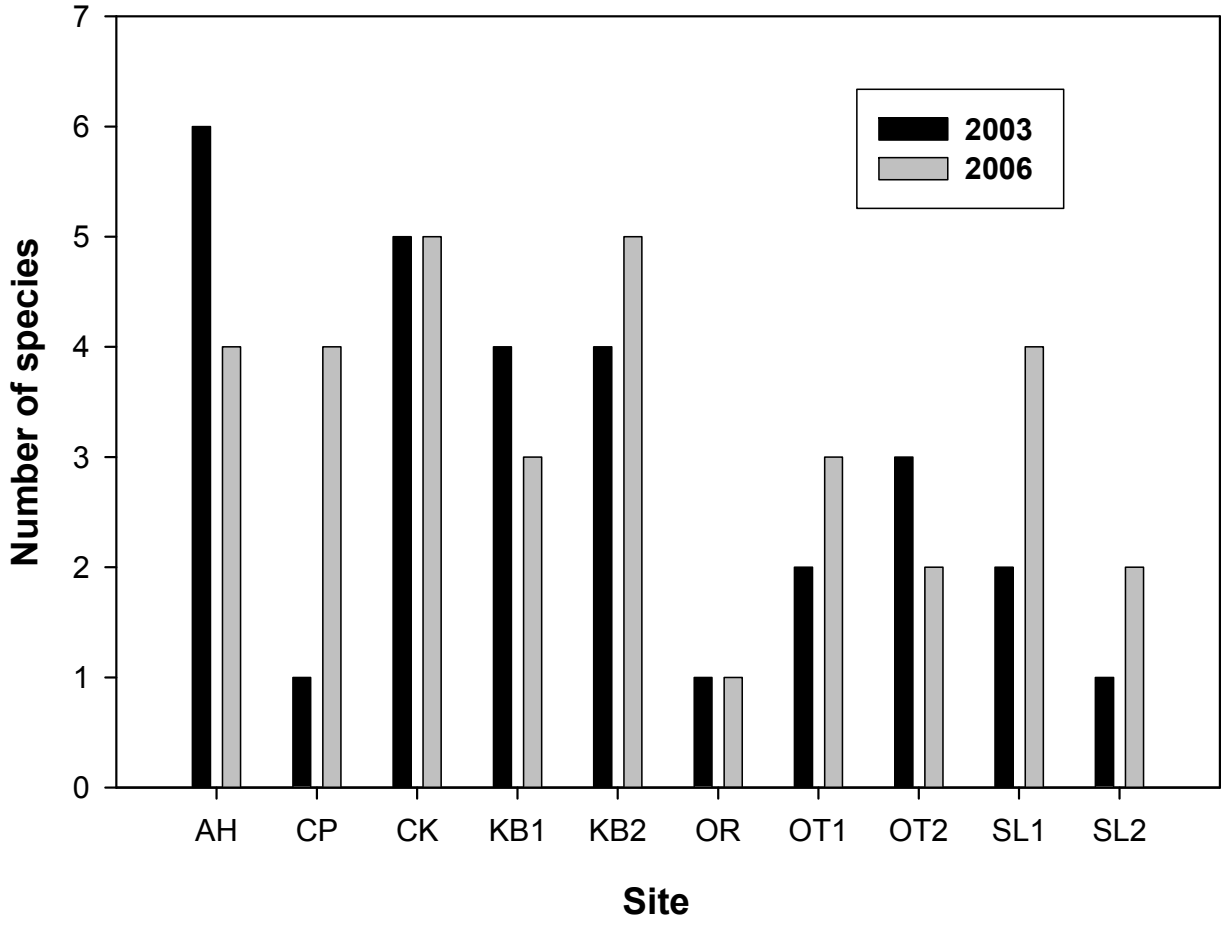


Figure 2: Total number of beetles and beetle species caught in pitfall traps at three Port Hill reserves in 2006

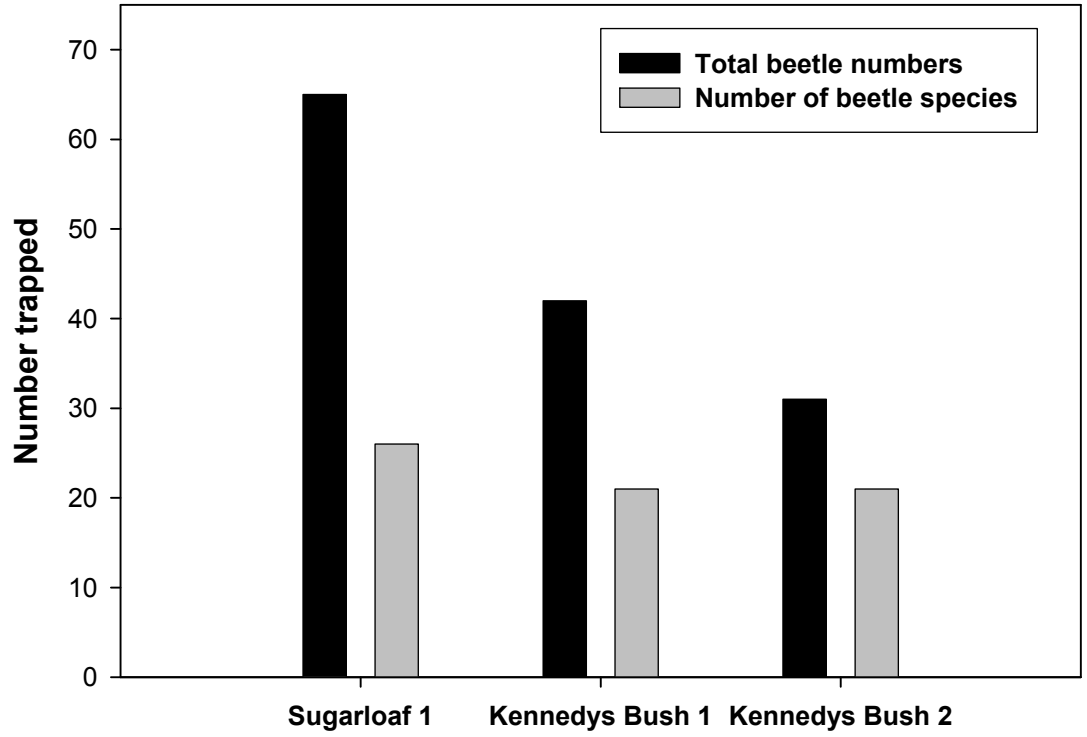


Figure 3: Beetle diversity at three Port Hills reserves collected from pitfall traps in Oct .- Nov. 2006

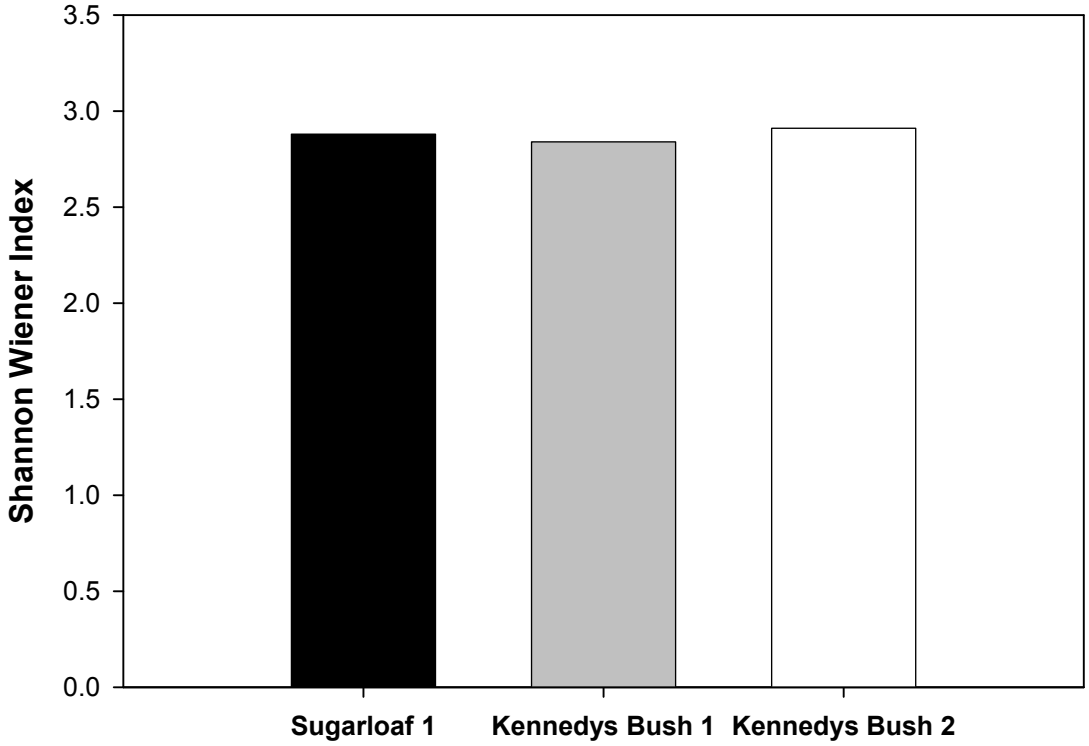


Figure 4: Total numbers of spiders and carabids at ten Port Hills reserves in 2003 and 2006

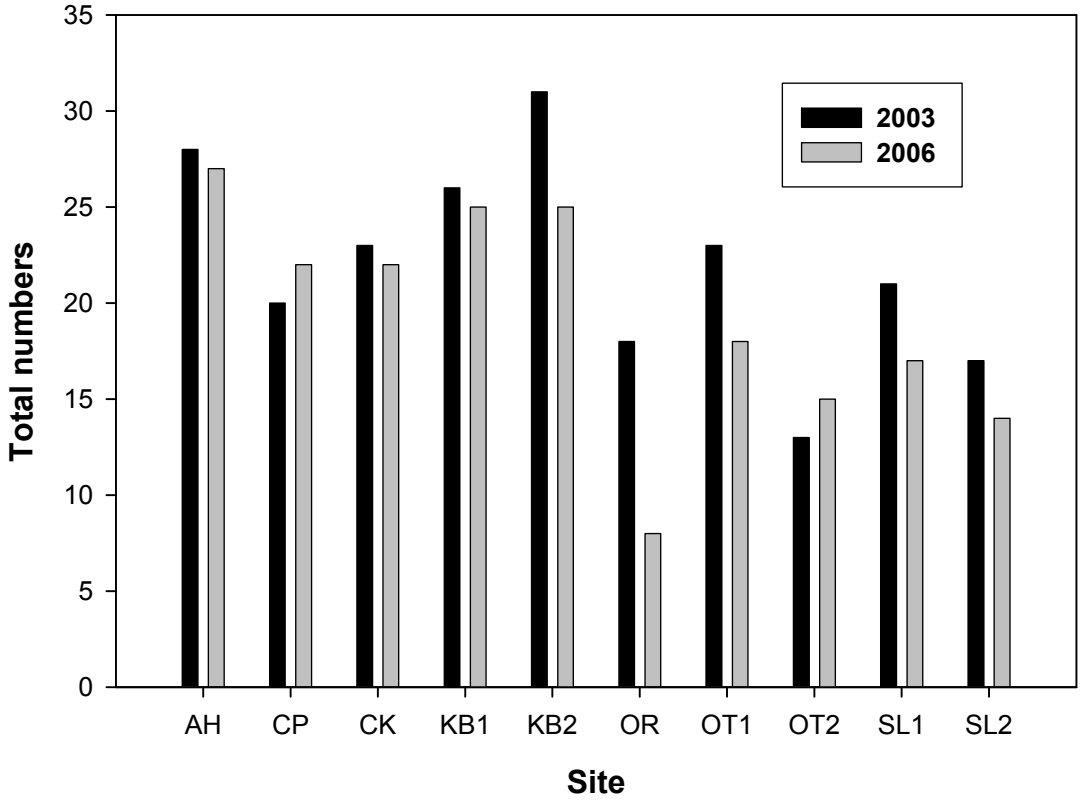


Table 2: Comparison of carabid numbers caught using wooden discs and pitfall traps at three Port Hills sites

Site	Wooden Discs Oct 2005	Pitfall traps Oct-Nov 2006	Totals
Sugarloaf 1	6	25	**31**
Kennedys Bush 1	9	4	**13**
Kennedys Bush 2	8	4	**12**

Discussion

Carabids

Perhaps the most significant finding was six specimens of *Onawea* (formally "*Argutor*" or "*Omaseus*") *pantomelas* (Johns, 2007). One was found under a wooden disc at Coopers Knob in 13 October 2006 and five more specimens from pitfall traps at the same location on 11 January 2006. The first specimen known to have been collected in 18 years on 14 December 2005, reported by Bowie and Vink (2006) along with the additional six collected above, indicates a population of this species may be recovering. It is difficult to be sure if predator control work or some other factor such as soil moisture is contributing to these beetles being found.

The two specimens of *Dicrochile whitei* identified from Kennedys Bush 1 pitfall traps were a good find because in four previous years sampling in the Port Hills only three other specimens have been found, all under discs – two at Kennedys Bush 1 and one at Otahuna 2 (Bowie and Sirvid, 2004; Bowie and Sirvid, 2005).

Other beetles

The large numbers of stag beetles (*Paralissotes reticulatus*) under wooden discs is likely to be due to the decayed state of the discs. In the damper Port Hill sites (Sugarloaf 2, Kennedys Bush, Otahuna 2 and Cass Peak sites), discs have succumbed to fungal attack which makes them moister and attractive to stag beetles. It is interesting that these beetles can successfully live on exotic pine and this may be significant in terms of restoration of this species in the future. The deteriorated state of these discs is likely to make these less suitable for carabid refuges (and sampling) and is likely to result in lower counts as a consequence. Although carabid numbers did not completely reflect this (Fig. 1) (e.g. in Cass Peak and Sugarloaf 2), the bad state of some of the discs is likely to have reduced their suitability as refuges and should be replaced 2-3 months before the next sampling.

Wooden discs vs pitfall traps

One interesting difference between the methods is the apparent inefficiency of the pitfall traps to collect the two smallest carabid species *Oopterus laevicollis and Zabronothus striatulus*. Ten of these two species were collected under wooden discs at Sugarloaf 1 and Kennedys Bush sites, yet none were collected from pitfall traps at the same three sites (Appendix 2 and 3). It is likely that pitfall traps may be more efficient for larger carabids as they tend to travel quicker and are more likely to blunder into the traps than are smaller carabids. Another observation is the large number of one carabid species which are sometimes caught in a single trap. One possible explanation for this is the use of pheromones by some species to locate mates which may end up in a pitfall, only for others to follow and end up trapped also.

Motels

The good finding in the motels was the tree weta found at the Sugarloaf sites. It will be interesting to see if these populations increase over time but as they only last about 12 months as adults, the current individual may die of natural causes within one year.

Large numbers of leaf vein slugs were found at some sites. A total number of 68 slugs were found in weta motels, with 27 of them being found at Orongomai**.** No slugs were found at Coopers Knob or Otahuna 2

Predator control

Vertebrate pest control in Kennedys Bush Reserve was reviewed by Thomas (2007), yet no mention was made of mouse numbers or control of this pest. Mice should be considered important if an attempt to restore invertebrate populations is an objective. Rats, mustelids and possibly hedgehogs can keep mouse numbers in check, but if these predators are trapped in numbers shown in Thomas (2007), mouse numbers can increase rapidly given sufficient food. Mice have caused the extinction of many invertebrates, particularly on islands (Marris, 2000), where flightlessness or geographic isolation restrict immigration. Most of larger invertebrates

found in the Port Hills are flightless (e.g. tree weta, carabids, leaf-vein slugs) and nocturnal making them extremely vulnerable to rodents and hedgehogs. If mice, rats or hedgehogs increase to significantly high densities, they can cause the local extinction of some invertebrates in isolated forest remnants. For this reason it is important monitor all pest vertebrate species, including mice. Creating corridors between isolated remnants also helps by allowing immigration/emigration to occur, reducing the chance of local extinction occurring in pest hotspots. Other than the issue above, I believe the recommendations by Thomas (2007) including alternating different bait types, are sound.

The final point to make is that it is very difficult to attribute changes in invertebrate diversity and/or abundance directly to vertebrate pest work. Many environmental factors influence invertebrate populations and without replicated control and treatment areas it is difficult to isolate the cause of fluctuations in species.

Summary

- Many wooden discs were decaying and contained stag beetles.
- Several tree weta were found in Sugarloaf Reserve weta motels.
- Many leaf-vein slugs (68) were found in weta motels especially at Orongomai.
- Coopers Knob and Kennedys Bush 2 showed the highest carabid species diversity.
- Kennedys Bush 2 and Ahuriri had the highest abundance of carabids and spiders.
- Orongomai was the poorest in terms of carabid species diversity and abundance.
- No clear trend was found at sites between invertebrate numbers or diversity between 2003 and 2006.
- The close relationship between pitfall and wooden disc results in 2005 (Bowie and Vink, 2006) was not evident with Sugarloaf 1 and Kennedys Bush sites in 2006 monitoring.
- Large numbers of hedgehogs and mustelids were trapped at Kennedys Bush (Thomas, 2007).
- Need to monitor mouse numbers if restoring invertebrates is considered an objective.

Recommendations

- A repeat of the Butcher and Emberson (1981) methodology would give an excellent comparison of carabid diversity and abundance at Ahuriri. This would give the best indication of how the Port Hills carabids 'shape up' since the survey 30 years ago.
- Replace wooden discs at all sites within three months of the next sampling period.
- Continue monitoring of invertebrates using existing methodology using motels and discs in 2008.
- Continue with vertebrate pest control but include mouse monitoring, particularly where larger predator species are being controlled.

Acknowledgements
Thanks to Bruce Marshall (Te Papa), Peter Johns (Canterbury Museum) and John Marris (Lincoln University) for identification of specimens.

References

Bowie M.H. and Frampton C.M. 2004. A practical technique for non-destructive monitoring of soil surface invertebrates for ecological restoration programmes. *Ecological Management and Restoration 5(1)*: 34-42.

Bowie, M.H., Marris, J.W.M., Emberson, R.M., Andrew, I.G., Berry, J.A., Vink, C.J., White, E.G., Stufkins, M.A.W., Oliver, E.H.A., Earl,y J.W., Klimaszewski, J., Johns P.M., Wratten, S.D., Mahlfeld, K., Brown, B., Eyles, A.C., Pawson, S.M. and Macfarlane, R.P. 2003. A terrestrial invertebrate inventory of Quail Island (Otamahua): towards the restoration of the invertebrate community. *New Zealand Natural Sciences 28*: 81-109.

Bowie, M.H. and Sirvid, P. 2004. Invertebrate diversity and abundance in ten Port Hills reserves, Canterbury. *Wildlife Management Report* No. 34. Lincoln University. 13pp.

Bowie, M.H. and Sirvid, P. 2005. Measuring ecosystem recovery: diversity and abundance of invertebrates in ten Port Hills reserves, Canterbury. *Wildlife Management Report* No. 35. Lincoln University. 15pp.

Bowie, M.H., Hodge, S., Banks, J. and Vink C.J. 2006. An appraisal of simple tree-mounted shelters for non-lethal monitoring of weta (Orthoptera: Anostostomatidae and Rhaphidophoridae) in New Zealand nature reserves. *Journal of insect conservation 10*: 261-268.

Butcher, M.R. and Emberson, R.M. 1981. Aspects of the biology of carabid beetles of Ahuriri Bush Scenic Reserve, Banks Peninsula. *Mauri ora 9*: 59-70.

Hodge, S., Vink, C. J., Banks, J. C. and Bowie, M. H. 2007. The use of tree-mounted artificial shelters to investigate arboreal spider communities in New Zealand nature reserves. *Journal of Arachnology* **35,** 129-136.

Johns, P.M. 2007. New genera and species of rare New Zealand endemic carabids (Coleoptera: Carabidae). Unpublished report. 10pp.

Klimaszewski, J. and Watt, J.C. 1997. Coleoptera: family-group review and keys to identification. *Fauna of New Zealand 37*. Manaaki Whenua Press, Lincoln. 199pp.

Krebs, C.J. 1989. Ecological methodology. Harper Collins Publishers. New York. 654pp.

Lang, A. 2000. The pitfalls of pitfalls: a comparison of pitfall catches and absolute density estimates of epigeal invertebrate predators in arable land. *Journal of Pest Science 73*: 99-106.

Thomas, M. 2007. Review of vertebrate pest control in Kennedys Bush reserve. Unpublished report prepared for the Christchurch City Council. 13pp.

Topping, C.J. and Sunderland, K.D. 1992. Limitations to the use of pitfall traps in ecological studies exemplified by a study of spiders in a field of winter wheat. *Journal of Applied Ecology 29*: 485-491.

Wilson, H.D. 1992. Banks ecological region. Port Hills, Herbert and Akaroa Ecological Districts. *Protected natural areas programme survey report no. 21* (for the Department of Conservation).

Table 4: Checklist of arthropod species found at ten reserves on the Port Hills in 2003-5 surveys

ORDER / Family	Common name	Species and locations found
AMPHIPODA	**Litter hoppers**	
Taltricidae		?*Makawe hurleyi* (Duncan) AH,CK,CP,KB1,KB2,OR,OT1,OT2,SL1,SL2
ANNELIDA	**Earthworms**	
TUBELLARIA	**Flatworms**	
Geoplanidae		?'*Newzealandia*' sp. CK,CP,KB1,KB2,OR,OT1,SL1,SL2
CHILOPODA	**Centipedes**	
Henicopidae?		Unidentified species 1 AH,CK,CP,KB1,KB2,OT1,OT2,SL1,SL2
COLLEMBOLA	**Springtails**	
Tomoceridae		Unidentified species 1 AH,CK,CP,KB1,KB2,OR,OT1,OT2,SL1,SL2
DIPLOPODA	**Millipedes**	
Dalodesmidae		*Icosidesmus* sp.
MOLLUSCA	**Molluscs**	
Athoracophoridae	**Native slug**	?*Pseudaneitea* sp. AH,CK,KB1,KB2,SL2
Charopidae	**Native snail**	*Charopa pseudocoma* Suter KB1,CP,CK,OR,OT2,SL1,OT2
		Flammulina crebriflammis (Pfeiffer) KB2
		Flammulina perdata (Hutton) OT2,SL1
		Flammulina zebra (Le Guillou) CK,CP,KB2,OT2,SL2
		Thalassohelix igniflua (Reeve) KB2
Punctidae		sp. 50 "*Kokopapa monospathulata*" KB1
OPILIONES	**Harvestman**	
Triaenonychidae		?*Nuncia* sp. CK,KB1,KB2,OR,OT2,SL1,SL2
TUBELLARIA	**Flatworms**	
Geoplanidae		?'*Newzealandia*' sp. CP,CK,KB1,KB2,OR,OT1,SL1,SL2
ARANEAE	**Spiders**	
Araneidae		*Zealaranea crassa*? (Walckanaer) SL2
Agelenidae		*Neoramia janus* (Bryant) AH, CK, CP, KB1,KB2,OR
		Neoramia setosa (Bryant) AH, CK,CP,KB2,OR,OT1,OT2,SL1,SL2
Amphinectidae		*Maniho ngaitahu* Forster and Wilton* SL1
Desidae		*Nuisiana arboris* (Marples) AH, CK, KB1, KB2, OT1, OT2, SL1,SL2
Hexathelidae	**Tunnel web spiders**	*Porrhothele antipodiana* (Walckenaer) AH,CP,CK,OR, OT1
Idiopidae	**Trap door spider**	*Misgolas* ?*borealis* (Forster) CP,OR,OT1,SL2
Malkaridae		Undescribed sp. SL1
Stiphidiidae	**Sheet web spiders**	*Cambridgea peelensis* Blest and Vink CP,OT2
		Cambridgea quadromaculata Blest and Taylor AH,CK,KB2,OR
Theridiidae	**Cobweb spiders**	*Theridion zantholabio* Urq. AH, CK,CP,KB1,KB2,OR,OT1,OT2, SL1,SL2
		Achaearanea veruculata (Urquhart) KB2, OT1,SL1
Zoropsidae		*Uliodon* sp. AH,KB1,OT2,SL1,SL2
COLEOPTERA	**Beetles**	
Carabidae	**Ground beetles**	*Dicrochile whitei* (Csiki)* KB1,OT2
		Holcaspis angustula (Chaudoir) AH, CK, OR, KB1,SL1
		Holcaspis elongella (White) AH, CK, OR, KB1, KB2, OT1, OT2, SL1
		Holcaspis intermittans (Chaudoir) AH, CK, CP, KB2, OT1, OT2
		Holcaspis suteri Broun* AH, CK,OR, CP, KB1, KB2, OT1, OT2, SL1
		Lecanomerus latimanus Bates KB1
		Mecodema oregoides (Broun)* AH, CK, CP, KB2, OT1, SL1
		Megadromus antarcticus (Chaudoir) AH, OR, KB2, SL1
		Oopterus laevicollis Bates* CK, KB1,SL1,SL2
		Onawea pantomelas (Blanchard)* CK
		Selenochilus piceus (Blanchard)* AH
		Zabronothus striatulus Broun* AH,CK,OT2, SL1,SL2
Cerambycidae	**Longhorn beetles**	*Coptomma sulcatum* (Fabricus) OR
		Somatidia sp. KB1
Cerylonidae		?*Philothermus* sp. 1 AH,CK
		Nodulosoma sp. 1 CK
		Nodulosoma sp. 2 AH
Clambidae		?*Clambus* sp. CK, KB1
Coccinellidae		*Ryzobius* sp.
		?*Veronicobius* sp. AH
Corticariidae		*Enicmus* sp. OR
Corylophidae		Unidentified species 1 CK,OR, KB1, KB2
		Unidentified species 2 CK,OR
Cryptophagidae		Unidentified species 1 CK,OR
Curculionidae	**Weevils**	*Pentarthrum* sp. OR

		Unidentified species 1 KB1
		Unidentified species 2 KB1
		Unidentified species 3 KB1
		Unidentified species 4 KB1
		Unidentified species 5 KB1
		Unidentified species 6 KB1
		Unidentified species 7 KB1
		Unidentified species 8 KB1
Histeridae	**Pill beetles**	?*Parepierus* sp. CP,SL1
Lathridiidae	**Mildew beetles**	*Aridius nodifera* (Westwood) AH,OR
		Bicava sp. AH, CK,OR, KB1, KB2
		Lithostignus sp. CK, KB1
		Metophthalmas sp. OR
Lucanidae	**Reticulate stag beetle**	*Paralissotes reticulatus* (Westwood) AH, CP, KB2
Melandryidae		*Hylobia ?plagiata* Broun CK , SL1
Mycetophagidae	**Hairy fungus beetles**	Unidentified species 1 AH, KB1
Nitidulidae	**Fruit beetles, sap beetles**	*Platypidia* sp. CK
Scarabaeidae	**Grass grub**	Unidentified (larvae) AH,KB2,SL1
Scraptiidae		Unidentified species 1 SL1
Staphylinidae	**Rove beetles**	*Baeocera* sp. 1 KB1,KB2, SL1
		Microsilphinae SL1
		Pselaphinae AH,OR, KB2
		"*Quedius*" sp. AH
		Unidentified species 1
		Unidentified species 2
		Unidentified species 3
		Unidentified species 4
Tenebrionidae	**Darkling beetles**	*Artystona wakefieldi* Bates OT1,SL1,OR,SL1,SL2
		Zealandelium zealandicum (Bates) CP
Zophoridae		*Epistranus* sp. KB2,SL1
		Tarphiomimus sp. KB2,SL1
		Pristoderus bakewelli (Pascoe) CK,OR,OT1,SL2,AH,CP,KB1,KB2,OT2
DIPTERA	**Flies**	Unidentified species
HYMENOPTERA	**Wasps, ants and termites**	
	Ants	Unidentified species
LEPIDOPTERA	**Moths and butterflies**	Unidentified species
ORTHOPTERA	**Weta, grasshoppers, etc**	
Anostostomatidae	**Canterbury tree weta**	*Hemideina femorata* (Hutton) OT1,SL2,SL1
Raphidophoridae	**Cave weta**	*Isoplectron calcaratum* Hutton OT2,SL1,SL2, KB1,KB2

*** Banks Peninsula endemic**

AH = Ahuriri
OR = Orongomai
CK = Cooper's Knob
OT = Otahuna
SL = Sugarloaf
CP = Cass Peak
KB = Kennedys Bush

Appendix 1: Species and numbers of spiders and large invertebrates collected in motels at ten Port Hills sites

Species	Port Hills reserve										
	AH	**CP**	**CK**	**KB1**	**KB2**	**OR**	**OT1**	**OT2**	**SL1**	**SL2**	**Totals**
Empty motels	1	1	3	3	1	3*	2	3	5	4*	
Spiders											
Neoramia spp.	10	14	10	10	10	4	10	6	5	4	**83**
Therid	4		4	5			3	3	3	5	**27**
Cambridgea spp.			1	1	5	1	1	4	1	1	**15**
Achaearanea veruculata											
Porrhothele antipodiana	4	1	1		1						**7**
Nuisiana arboris						3			1		**3**
Unidentified spider sp.	1	2	1		1				1	2	**8**
Immature spider											
Totals	**19**	**17**	**17**	**16**	**17**	**8**	**14**	**13**	**11**	**12**	**143**
Other invertebrates											
Weta											
Isoplectron calcaratum							2		2		
Hemideina femorata									1	4	
Native slug	6	4		8	4	27	10		8	1	
Beetles											
Artystona wakefieldi		1									
Coccinelidae											
Coptomma sulcatum											
Curculionidae		2									
Staphylinidae											
flatworm					1						
Miscellaneous											
Earwig											
Lepidoptera larvae									1		
Cockroach						1			1		
Snail				1	1		1			1	

Key to reserves:
AH = Ahuriri
CP = Cass Peak
CK = Cooper's Knob
KB = Kennedy's Bush
OR = Orongamai
OT = Otahuna
SL = Sugarloaf
*** Motel not found / replaced with new one**

Appendix 2: Species and number of invertebrates collected from wooden discs ten Port Hills sites in 2006

Invertebrate species	Port Hills reserve										
	AH	CP	CK	KB1	KB2	OR	OT1	OT2	SL1	SL2	Totals
Carabidae											
Dicrochile ?atratus		✓					✓				
Holcaspis angustula		1	1								**2**
Holcaspis elongella					1			1	1		**3**
Holcaspis intermittans		1		1	2		2	✓			**6**
Holcaspis suteri	2	1						1			**4**
Mecodema oregoides	2	2	1		2	1	1		2		**11**
Megadromus antarcticus	1[L]			4			1				**6**
Oopterus laevicollis			1	4	2				1	1	**9**
Zabronothus striatulus	3		2		1				2	1	**9**
Onawea pantomelas			1								**1**
Totals	**8**	**5**	**5**	**9**	**8**	**1**	**4**	**2**	**6**	**2**	**50**
Other beetles											
Curculionidae species 1 (S)		1		1	2	7			1		
Curculionidae species 2 (L)		1		2	3	6	1		1		
Curculionidae species 3		2		2							
Histeridae ?*Parepierus* sp.											
Scarabiidae		1									
Staphylinidae	1								2		
Paralissotes reticulatus		3		8	3			5		13[L]	
Pristoderus bakewelli	1	6		10	44	5	1	2			
Zeadelium zealandicum		2									
Unidentified Coleopteran	3	1	1	27	64	1	2	1	28		
Miscellaneous											
Native slugs	2								1		
Native snails	29		4	5	16	1	5		6		
Chilopoda (centipede)	12	11	10	8		11	4		4	1	
Diplopoda (millipede)	9	1	25	3	1	3			8	1	
Amphipoda (Taltricidae)											
Native opiliones	2	2	2	5	37	13				6	
Tubellaria (flatworms)	5	1	1	6	5		1				
Annelida (earthworms)	23	27	9	8	7	11	6		6		
Ant colony							1	2			
Mites						1					
Spiders											
Cambridgea sp.					3	1					
Maniho ngaitahu											
Misgolas sp. (Trapdoor)					1						
Porrhothele antipodiana	5	2	3		2	1	1				
Theridiidae											
Uliodon sp. (Zoropsidae)					3				2		
Unidentified spiders		2	3		3	5	4		7	2	

Key to reserves:

AH = Ahuriri
CP = Cass Peak
CK = Cooper's Knob
KB = Kennedy's Bush
OR = Orongomai
OT = Otahuna
SL = Sugarloaf
[L] = larvae (not adult)
✓ = species found but not under disc

Appendix 3: Species and number of invertebrates collected from pitfall traps at Sugarloaf Reserve site 1, Kennedy's Bush reserve sites 1 and 2.

COLEOPTERA (BEETLES)	**SITE**				
FAMILY– species	**KB1**		**KB2**		**SL1**
CARABIDAE – *Dicrochile ?atratus*	2				
CARABIDAE – *Holcaspis angustula*					5
CARABIDAE – *Holcaspis elongella*	1				1
CARABIDAE – *Holcaspis intermittans*			3		
CARABIDAE – *Holcaspis suteri*	1				15
CARABIDAE – *Mecodema oregoides*					3
CARABIDAE – *Megadromus antarcticus*			1		1
CARABIDAE – *Oopterus laevicollis*					
CARABIDAE – *Zabronothus striatulus*					
CARABIDAE – *Onawea pantomelas*					
CERAMBYCIDAE – *Somatidia* sp.	1				
CLAMBIDAE – *Clambus* sp.	1				
CORYLOPHIDAE – species 1	1		1		
CURCULIONIDAE – species 1 (L)	2				4
CURCULIONIDAE – species 2 (L)			1		2
CURCULIONIDAE – species 3 (M)	4		1		1
CURCULIONIDAE – species 4 (M)	1		1		1
CURCULIONIDAE – species 5 (S)	3		1		2
CURCULIONIDAE – species 6 (S)	2		4		2
CURCULIONIDAE – species 7 (S)	1				
CURCULIONIDAE – species 8 (S)	1				
HISTERIDAE – ?*Parepierus* sp					1
LATHRIDIIDAE – *Bicava* sp. 1 (dark markings)	2		1		
LATHRIDIIDAE – *Bicava* sp. 2 (2 dimples)			1		
LATHRIDIIDAE – *Lithostygnus* sp.	1				4
LEIODIDAE – species 1					1
LEIODIDAE – species 2	1				
LEIODIDAE – species 3			1		
LUCANIDAE – *Paralissotes reticulatus*			1		2
MELANDRYIDAE – *Hylobia ?plagiata*					1
MELANDRYIDAE – species 2					1
MELANDRYIDAE – species 3					1
MYCETOPHAGIDAE – species 1	2				
SCRAPTIIDAE– species 1					1
STAPHYLINIDAE – Microsilphinae					1
STAPHYLINIDAE – *Baeocera* sp.	7		3		5
STAPHYLINIDAE – Pselaphinae			1		
STAPHYLINIDAE – species 2	2		1		2
STAPHYLINIDAE – species 3	2		2		2
STAPHYLINIDAE – species 4			2		2
STAPHYLINIDAE – species 5			1		1
TENEBRIONIDAE – *Zeadelium zealandicum*					
ZOPHERIDAE – *Epistranus* sp.			2		2
ZOPHERIDAE – *Pristoderus bakewelli*	4		1		
ZOPHERIDAE – *Tarphiomimus* sp.			1		2
Number of beetle species	21		21		26
Total number of beetles	42		31		65
Diversity Index	2.84		2.91		2.88
Standard Deviation	0.102		0.098		0.102

Key to reserves:
SL = Sugarloaf
KB = Kennedy's Bush

MISCELLANEOUS	SITE				
	KB1		KB2		SL1
Native snails			5		
Chilopoda (centipede)	1				1
Diplopoda (millipede)					
Amphipoda (Taltricidae)					
Native opiliones	1				1
Tubellaria (flatworms)					
Annelida (earthworms)					
Cave weta	1		1		

Key to reserves:
SL = Sugarloaf
KB = Kennedy's Bush